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Role Of Ultrasonography And Color DopplerInIntrauterine Growth Restriction For Prediction Of Adverse Perinatal Outcome- A Prospective Study

Dr Paresh Bhowmik, Dr (Prof) J. K. Podder.Dr(Prof)Pardip Kumar Deb, Dr. Jaybrata Roy

Deparment Of Radiodiagnosis ,Agartala Government Medical College And Govind Ballabh Pant Hospital , Agartala.

Objectives: *To determine umbilical artery PI and PI of middle cerebral artery and the MCA PI/UA PI ratio to assess the fetal hypoxia by Color Doppler study and its adverse effect on perinatal outcome.*

Methodology: *A total 50 cases of clinically suspected IUGR pregnant mothers were enrolled in our study and all of them were evaluated by Colour Doppler study,following detailed clinical examination. In colour Doppler study umbilical artery flow Pulsatility index(PI)in regards to normal, reverse and absent end diastolic flow were recorded. PI index of Middle Cerebral artery was measured in each case and ratio of MCA PI &UA PI were calculated. All those 50 cases were followed up till early neonatal period. Fetal outcome in respect of umbilical and middle cerebral artery flow and MCA PI & UA PI ratio were recorded.*

Result: *Out of 50clinically suspected IUGRcases, 7 were intrauterine fetal deaths and 43 live births. Out of 7 intrauterine deaths ,4(100%) cases have reversal of umbilical artery diastolic flow & 3(33%) have absent umbilical artery diastolic flow.*

Out of 43 live births, low Apgar score were 7cases.Emergency c/s were 12 cases & admission in NICU 8cases.

Conclusion: *From this study we concluded that the Cerebroplacental ratio (MCA PI/UA PI) was most sensitive(95,8%) & it was more sensitive than either UA PI (91%) or MCA PI (87.5%)alone in prediction of adverse perinatal outcome. Cerebroplacental ratio & UA PI were equally specific(specificity = 84.6%) & MCA PI have comparatively low specificity(46%).*

Keywords*: - Intrauterine Growth Retardation, Pulsatility Index, revers diastolic flow, absent diastolic flow , cerebral redistribution, umbilical artery(UA), middle cerebral artery(MCA) ,MCA PI/ UA PI ratio and reduced diastolic flow.*

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I. INTRODUCTION

IUGR fetuseshave a 30-50% likelihood of intrapartum hypoxic distress and a 50% risk of neonatal complications caused by fetomaternal and placental conditions. Neonatal complications that include hypoglycaemia, meconium aspiration pneumonia and long-term growth impairment like neurodevelopment disability, cardiovascular disorders etc.[1]The perinatal mortality is 3.6% in IUGR[2].

IUGR is defined as a fetal growth less than 10^{th} percentile for the gestational age. The IUGR may be symmetric and asymmetric.[3]Approximately 70 percent of fetuses with a birth weight below the 10^{th} percentile for gestational age are constitutionally small and the remaining 30 percent; the cause of IUGR is pathologica[4]

Ultrasonographic biometry helps to identify a heterogeneous group of small for gestational age fetuses that include fetuses with IUGR, fetuses with small constitution, and fetuses with appropriate growth (misdiagnosed as small)l[5,6] .

The Colour Doppler study is a better tool to detect the IUGR.[7] The normal value of Umbilical Artery Pulsatility Index (UAPI) is2.0 in the early second trimester and around 1.0 near term [8].The absent or reversed end-diastolic flow in umbilical artery signifies increased impedance to umbilical artery blood flow. It is due to poorly vascularised placental villi and is seen in extreme cases of fetal growth restriction. The hypoxic growth restricted fetus attempts brain sparing by reducing cerebrovascular impedance and thus increasing blood flow to brain[3].Doppler US studies of the human fetal circulation have shown that in fetuses with IUGR there is a significant reduction of Middle Cerebral Arterial Pulsatility Index (MCAPI) when compared with those in normal fetuses[9].Results of several studies suggest that the MCA PI/UA PI(C/U) Doppler ratio is more accurate in the prediction of adverse perinatal outcome than UA Doppler US alone[10, 11, 12].

The purpose of this study was to know usefulness of colour Doppler study of umbilical artery and middle cerebral artery for prediction of adverse perinatal outcome in clinically suspected Intrauterine Growth Retarted Pregnancies which is one of the most important perinatal syndromes and is a world-wide problem.

II. METHODOLOGY

50 clinically suspected IUGRpatients were recruited from antenatal OPD and Obstetric ward of the Department of Obstetrics &Gynecology,Agartala Government Medical College and Govind Ballabh Pant Hospital , Agartala ,between January 2013 and December 2014 prospectively.The study was approved by the Ethical Committee of Agartala Government Medical College &Govind Ballabh Pant Hospital, Agartala, Tripura.

The study was conducted in the Department of Radio-Diagnosis in collaboration with Department of Obstetrics and Gynecology of Agartala Government Medical College &Govind Ballabh Pant Hospital, Agartala, Tripura. Doppler Ultrasonography evaluation was performed after the grey scale USG assessment. Follow up Doppler Studies were performed if clinically indicated to determine a favorable or a worsening trend in the Doppler indices.

However, only the results of the first Doppler ultrasound were used for analysis of perinatal outcome.

The Doppler wall filter was set at 50-100Hz.The patients were allowed to rest for 10 to 15mins in a semi-recumbent position prior to commencing the ultrasound investigation. Fetal biometry was obtained initially. The waveforms were obtained during fetal inactivity and apnoea. Umbilical artery Doppler flow velocity waveforms were obtained from a free loop of cord, and measurements taken when a clear waveform was acquired in the absence of fetal breathing or body movement.

The Pulsatility index (PI) was measured, and the presence or absence of end-diastolic frequencies was noted. The PI was used as it continues to reflect changes in resistance with progressive absence of end –diastolic frequencies or reverse flow, and the values are normally distributed in third trimester .For MCA Doppler US, a transverse image of the fetal head was obtained at the level of the sphenoid bones. Color flow imaging was used to display the circle of Willis. The MCA in the near field was insonated about 1cm distal to its origin from the internal carotid artery and spectral waveforms are obtained .

Outcome Criteria:

Doppler US results were analyzed for prediction of perinatal outcome. Outcome variables included: 1.Birth weight,2. Perinatal death.3.Emergency CS for fetal distress.4.Low Apgar score(5min Apgar score less than 7)5.Admission to NICU for complications of low birth weight'Pregnancy was considered to have "Adverse outcome" when any of aboveevents were present.Pregnancy outcome was considered to be uneventful or Favourable when the above complications were absent.

The outcome for each pregnancy was obtained by examining the labour ward records and neonatal intensive care unit records wherever appropriate.

The UA pulsatility index ratios were considered abnormal if the value was above the 95th percentile of previously published values for gestational age [30].The MCA pulsatility index was considered abnormal if the value was below the 5th percentile of previously published values for gestational age[30].The MCA/UA PI ratio (cerebro-placental ratio) is usually constant during the last 10 weeks of gestation. In our study a single cut off value of MCA/UA PI ratio(1.08) was used, above which velocimetry was considered normal and below which it was considered abnormal.The sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy were determined for all Doppler measurements.

III. RESULTS

Of the 50 pregnancies studied acceptable wave forms were obtained from all the cases.7cases were followed up with repeat Doppler.Mean gestational age at the first Doppler US examination was 35.2 weeks +/- 3.46 weeks (2SD). 48% (n=24) fetuses had at least one abnormal outcome, of those; some (n=8) had more than one abnormal outcome. Remaining 26 fetuses had normal outcome.

TABLE: Table showing Pregnancy Outcome Uneventful Vs Adverse

Pregnancy outcome	No of cases	Percentage
Adverse	24	48%
Uneventful	26	52%

Mean birth weight at delivery was 2.43kg +/- 0.26 kg (2SD). 60% of neonates (n=30) had birth weight of less than 2.5kg.There were 7 intrauterine deaths and 43 live births. Of the 43 live births 8 neonates were admitted to NICU. 7 neonates had 5 min Apgar score less than 7 and 12 babies were born by emergency caesarean section.

In all cases with reversal of diastolic flow, IUFD of the fetus occurred within one week of diagnosis. And all the 4 cases were less than 32 weeks. One case of absent diastolic was 36weeks and remaining 2cases were 35 weeks of gestational age.

Cerebroplacental ratio (MCA/UA PI Ratio) was most sensitive (sensitivity 95.8%).It was more sensitive than either UA PI (sensitivity 91%) or MCA PI (sensitivity 87.5%) alone in predicting any adverse out come. Cerebroplacental Ratio and UA PI were equally specific (Specificity = 84.6%) and MCA PI had comparably low specificity (specificity = 46%).

Cerebroplacental Ratio had highest Positive Predictive Value (PPV=85%) followed by UA PI (PPV=84%) and MCA PI (PPV=60%).Negative Predictive Value of Cerebroplacental Ratio was 95% when compared to 91% for UA PI and 80% for MCA.

Diagnostic accuracy of Cerebroplacental ratio (Accuracy =90%) was better than UA PI (Accuracy=88%) and MCA PI (Accuracy=66%) in predicting adverse outcomes.

IV. DISCUSSION

When fetal growth retardation is diagnosed during the third trimester of pregnancy, the obstetrician must decide whether the fetus is "constitutionally" small or small as a consequence of impaired placental perfusion. Doppler flow velocity analysis can be valuable in resolving this question. The umbilical-placental and cerebral vascular beds are directly involved in the hemodynamic adjustments of fetal growth retardation.

A Doppler index that reflects both of these areas can be useful for identifying fetuses with increased placental and/or decrease cerebral resistance.

In the evaluation of the fetal cerebral circulation, the MCA is the most accessible vessel and it can be easily located on colour Doppler therefore the vessel of choice. It is the main branch of the circle of Willis and carries 80% of the blood flow to the ipsilateral cerebral hemisphere, a constant 3%-7% of cardiac output throughout gestation. Hence we used middle cerebral artery for the evaluation of fetal cerebral circulation.

We studied the Doppler index of umbilical artery only after 30^{th} week of gestation, because of agreement with Gramellini[11] we believe that it is difficult to define the normal or abnormal umbilical flow velocity before 30^{th} week, with the exception of absent end diastolic flow velocity after 20^{th} week. Further more in most cases clinical issues concerning asymmetrical growth retardation (placental insufficiency) arise after the 30^{th} week.

It is possible to use a single cut off value for Cerebroplacental ratio after 30^{th} week because cerebral-umbilical Doppler ratio does not vary significantly between 30^{th} and 40^{th} weeks as reported by Wladimiroff et al[25] who observed a significant differences in Cerebroplacental ratio only between 26-38wks.After 26^{th} week, the statistical comparison showed no significant differences between the intervals considered.Arbelle[31] et al also found the cerebral-placental ratio constant during the pregnancy and suggested 1 as the cut off value; all values below were considered abnormal.

Arduni and Rizzo[10] studied the test characteristics of the pulsatility index from the UA, MCA and RA to predict adverse perinatal outcome in 120 small –for gestational age fetuses. In 46.7% (56 of 120) of fetuses, there was at least one of the following adverse outcomes: perinatal death, caesarean section for fetal distress, 5minute Apgar score below 7,and asphyxia that necessitated admission to the neonatal intensive care unit for more than 48hours.By using the first Doppler US result for analysis, the author found that the UA/MCA Pulsatility index ratio was the best test when compared with MCA,UA and

Gramellini D, Folli MC, et al[11] concluded that the cerebral –umbilical Doppler ratio provided a better predictor of small for gestational age newborns and adverse perinatal outcome than either the middle cerebral artery or umbilical artery alone. In fact, in predicting those newborns that were small for gestational age, the cerebral umbilical ratio had a 70% diagnostic accuracy compared with 54.4% for the middle cerebral artery and 65.5% for the umbilical artery. The results were more encouraging for prediction of adverse perineal outcome; diagnostic accuracy for the cerebral-umbilical ratio was 90%, compared with78.8% for the middle cerebral artery and 83.3%for umbilical artery.

We have studied about 50 pregnancies with clinical suspicion of IUGR. Mean birth weight at delivery was 2.43kg +/-0.26kg(2SD).60% of neonates (n= 30) had birth weight of less than 2.5 kg.48%(n=24)fetuses had at least one adverse outcome; some (n=8) had more than one adverse outcome. Remaining 26 fetuses had favourable outcome. There were 7 intra uterine deaths and 43 live births .Of the 43 live births 8 neonates were admitted to NICU.7 neonates' had5 minutes Apgar score of less than 7 and 12 babies born by emergency caesarean section.

By using the first Doppler US results for analysis, the MCA/UA pulsatility index ratio had a higher sensitivity, Positive predictive value for adverse perinatal outcome than did the MCA pulsatility index and the UA PI.

Our findings agree with the results of the studies that have shown MCA/UA PI Doppler ratio to be more useful than UA PI or MCA PI in predicting adverse perinatal outcome [10, 11].

Comparison between different studies would be more meaningful if uniform or standardized criteria were used. Results of our studies conform with those of Fong et al[27] that MCA PI had low specificity in predicting adverse perinatal outcome. The normograms we chose to use for analysis are from the published cross –sectional study by Harrington K et all**[30].**

Our studies conform to those of Gramellini et all [11] that best results are obtained when we used MCA/UA PI Ratio, rather than PIs of middle cerebral artery and Umbilical artery separately.

TABLE: Perinatal Mortality Vs Absent /Reversal of DiastolicFlow

Spectral Characteristic	NO Of cases	IUD	Mortality
Absent EDF	09	03	33%
Reversed EDF	04	04	100%

The results of our study are comparable with Karsdorp et al[29].

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